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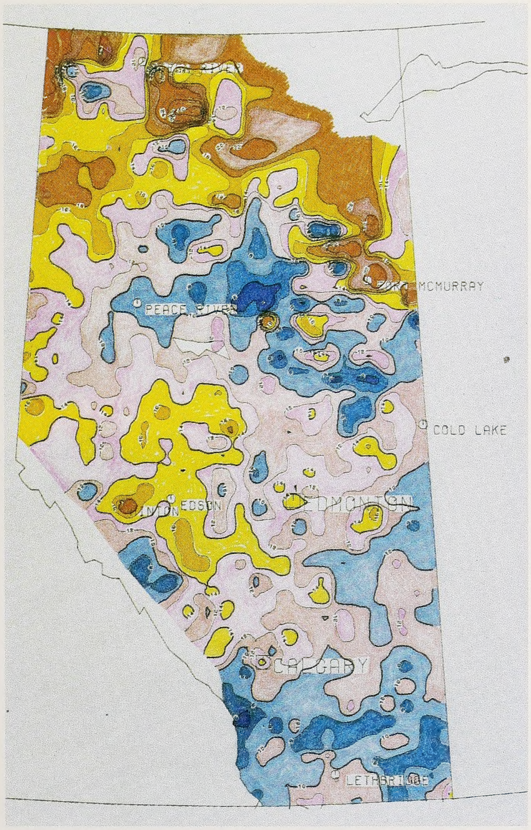
Geothermal Energy Resources in Alberta



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Cover: A thermal gradient map of Alberta, prepared during this study, shows how the temperature of underground water varies with depth beneath the surface. It was used to locate promising areas for recovery of geothermal energy.

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Disclaimer

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Foreword

Since 1976, numerous projects have been initiated in Alberta by industry and by academic research institutions which are aimed at better utilization of Alberta's energy resources.

These research, development and demonstration efforts were funded by the Alberta/Canada Energy Resources Research Fund (A/CERRF), which was established as a result of the 1974 agreement on oil prices between the federal government and the producing provinces.

Responsibility for applying and administering the fund rests with the A/CERRF Committee, made up of senior Alberta and federal government officials.

A/CERRF program priorities have focused on coal, energy conservation and renewable energy and conventional energy resources. Administration for the program is provided by staff within the Scientific and Engineering Services and Research Division of Alberta Energy.

In order to make research results available to industry and others who can use the information, highlights of studies are reported in a series of technology transfer booklets. For more information about other publications in the series, please refer to page 10.

Geothermal Energy Resources in Alberta

Earth scientists believe the sedimentary basin of porous and permeable rocks that underlies much of Alberta is a potential source of large amounts of low-grade, geothermal energy in the form of hot water. Within the basin are configurations of rocks and aquifers that are similar to conditions that have given rise to successful geothermal space-heating projects in other countries. These similarities suggested that a detailed examination of Alberta's geothermal potential was warranted, particularly because long lead times are required to develop alternative energy resources for the future

Consequently, a three-part investigation, funded by A/CERRF, was undertaken by staff of the Institute of Earth and Planetary Physics, Department of Physics, University of Alberta. Their findings were reported during the period October 1981 to October 1983 in three documents:

"An Investigation of Geothermal Energy Resources of Alberta"

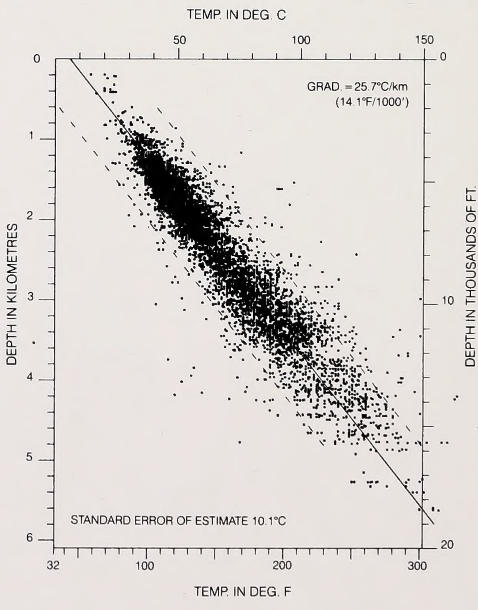
"A Detailed Study of Regions of Geothermal Energy Potential in Alberta"

"A Preparatory Study for Application of Geothermal Energy in the Hinton/Edson Area of Alberta".

Study Approach

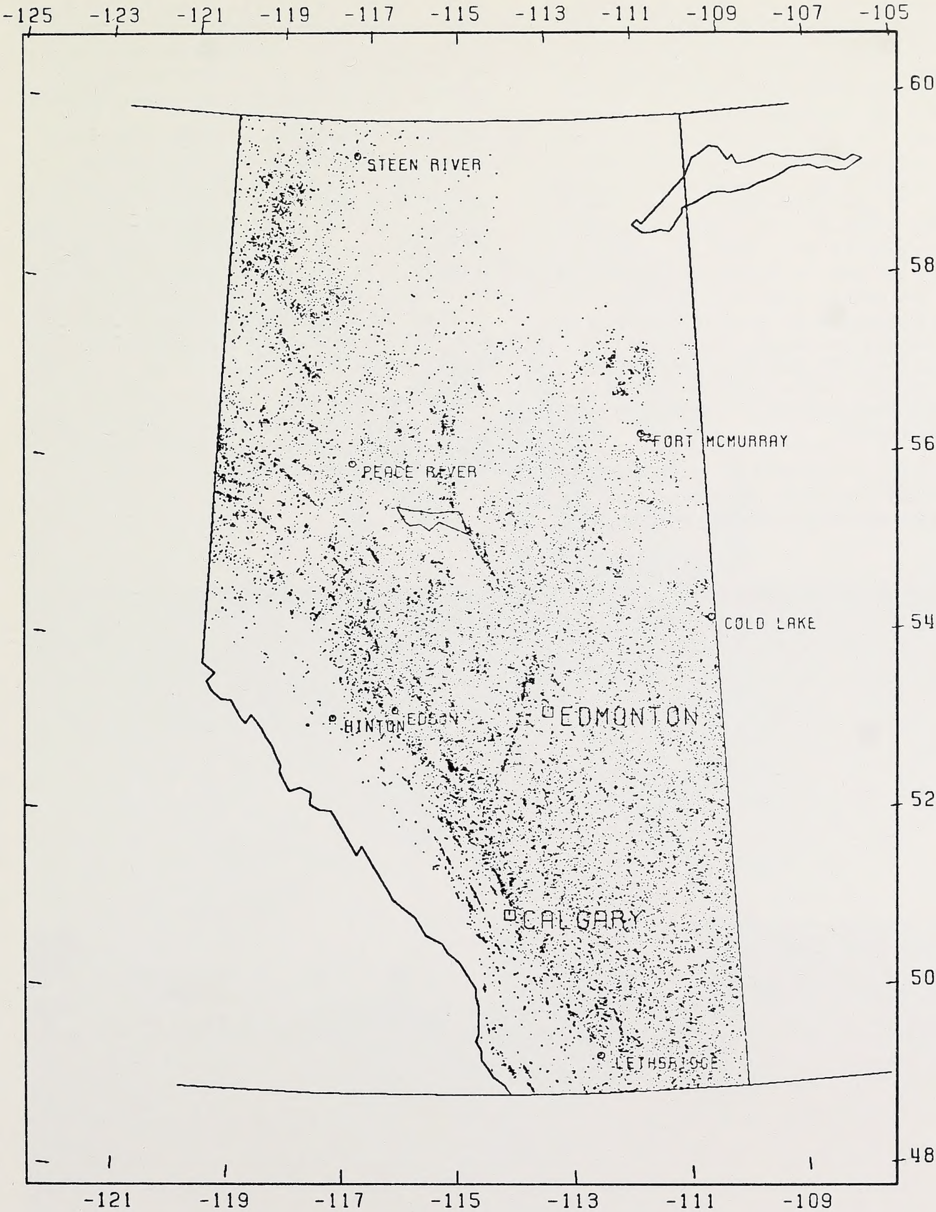
When oil and gas wells are drilled, various logs are run to determine the locations and characteristics of the different rock formations. Because a maximum reading thermometer is commonly attached to the logging tool to measure the temperature at the bottom of the hole, it was decided that water temperatures at various depths could be determined by reviewing existing well drilling logs. A lengthy inspection of the well drilling logs of 28 260 oil and gas wells on file with Alberta's Energy Resources Conservation Board produced 55 246 bottom hole temperature (BHT) values. They were used to estimate water temperatures at certain depths beneath the earth's surface, and they showed that subsurface temperatures increased with depth. These "geothermal gradients", as they are called, were mapped for all of Alberta, except Wood Buffalo National Park.

Temperature versus depth for all data from wells in the Hinton area.



(Source: *An Investigation of Geothermal Energy Resources of Alberta*, Jones F. W., H.L. Lam, and T.N. Nasr, October 30, 1981)

Location of wells for which temperature data were obtained.



(Source: *An Investigation of Geothermal Energy Resources of Alberta*,
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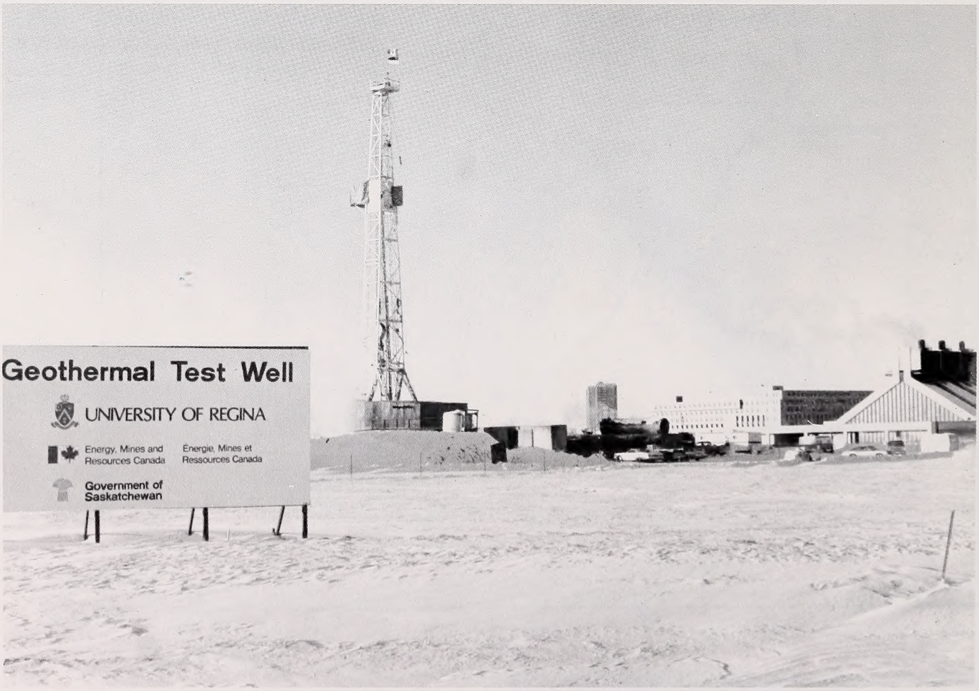
Results

While the geothermal gradients for much of Alberta were similar to values found in other parts of the world (averaging 26°C per kilometre of depth), in some locations gradients were less than 10° C per kilometre but in other areas high gradients exceeding 55°C per kilometre were found. High gradient areas were discovered in four general locations. They were the Hinton-Edson region, the Steen River area, Fort McMurray and an area in the northwest corner of the province. While these regions should represent areas of excellent potential for geothermal heat recovery, some of them are isolated from population centres, and recovery potential at Fort McMurray is limited because the wells are shallow. The discovery of these "anomalous" areas prompted a second phase of investigations aimed at quantifying the amount of energy that was recoverable from a high gradient area (Hinton) and a normal gradient area (Calgary). Another objective of the study was to propose methods for extracting geothermal heat and using it.

On the basis of data that had been logged for existing wells near both communities, fluid flow rates were estimated, heat recovery rates were-calculated and water chemistry characteristics were summarized. It was concluded that geothermal energy could be recovered from the deep sediments beneath both areas, but the Hinton region showed more promise because of higher temperatures, an above-normal thermal gradient (38°C per kilometre) and better flow rates.

Using existing data from five Hinton-area wells, values of recoverable energy were estimated. They ranged from a low of 1.8 megawatts (MW) — enough to satisfy the energy needs of 300 homes — to a high of 136 MW, which could supply the energy requirements of 22 000 homes. By comparison, an operational project at Los Alamos, New Mexico, has a capacity of 5 MW and a proposed electricity generating plant in British Columbia that would depend on geothermal energy, is rated at 55 MW.

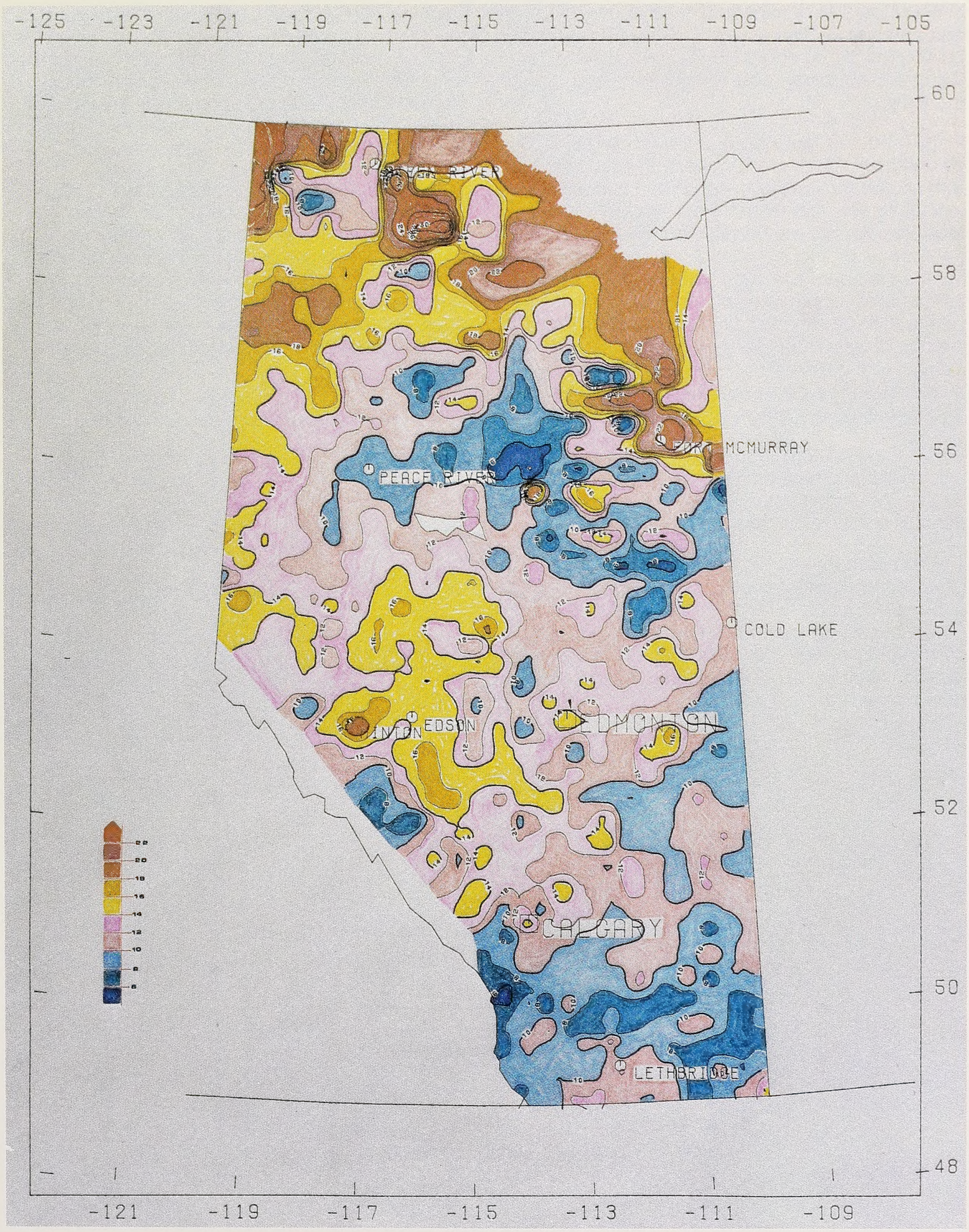
Also, a single well drilled to more than two kilometres below the University of Regina in 1979 found water at a temperature of 63°C, which is adequate to generate 3MW of electricity.



A Geothermal test well drilled on the University of Regina campus in 1979.

(Photo: Courtesy Energy Research Unit, University of Regina)

Thermal gradient map of Alberta in degrees Fahrenheit per thousand feet of depth.



The best reservoirs in Alberta were found between 2 and 3.5 kilometres below the surface in the carbonate formations of the Mississippian and Upper Devonian periods where water temperatures were expected to be above 70°C and perhaps as high as 150°C. Near Edson, water production at 100 cubic metres per hour was thought to be sustainable without excessive pumping.

In the third and final phase of the investigation, the University of Alberta researchers, in association with an energy specialist, described in detail the various factors that must be considered if further feasibility studies are undertaken for specific geothermal projects. For instance, they pointed out the importance of such aspects as reservoir temperature, depth and volume, rock permeability, water pumping characteristics and the role of water chemistry — in particular, salinity — in determining the need for, and types of, corrosion-resistant equipment used throughout the system.

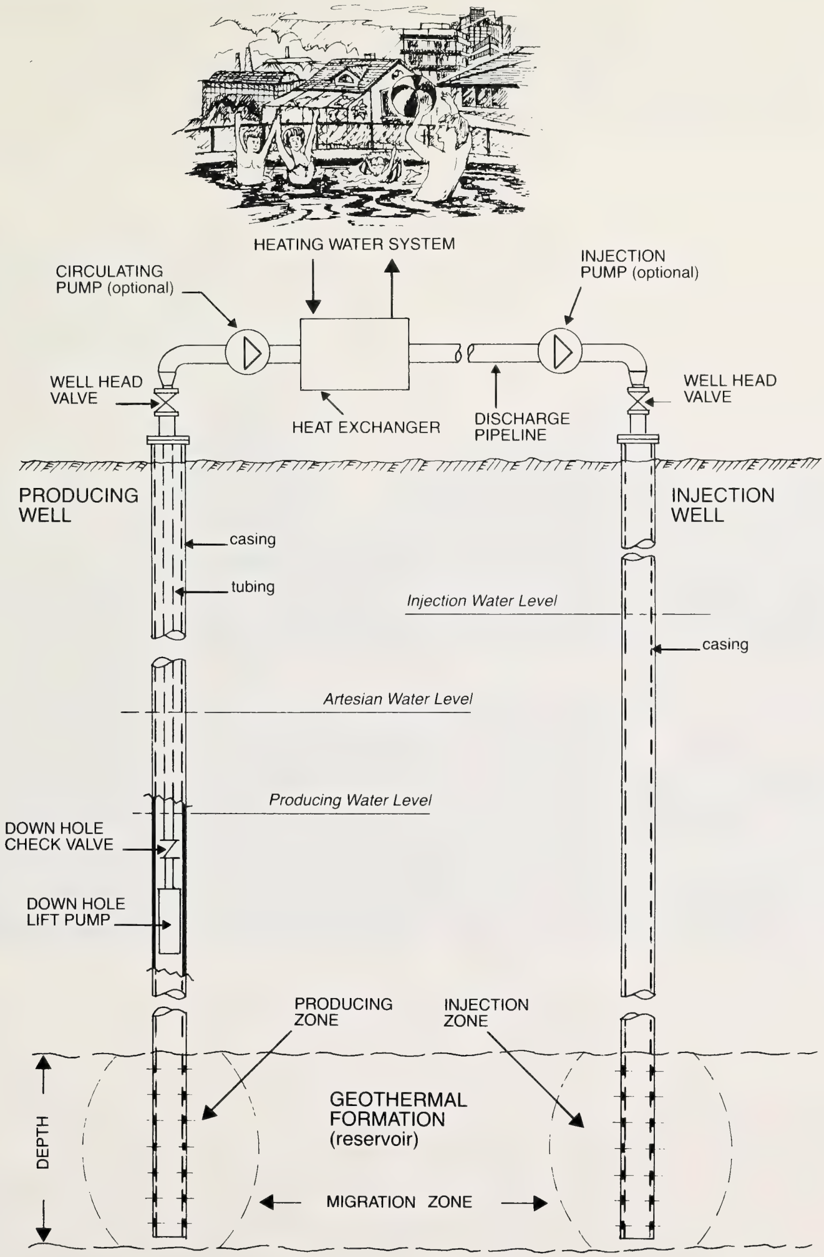
Also, mathematical models were used to calculate the impact on the temperature of an aquifer, when geothermal water is extracted, used and then reinjected.

The researchers investigated several prospective users of geothermal energy in a number of Alberta locations. They included greenhouses, agricultural research stations, a correctional institute near Bowden and two facilities near Hinton — a multi-use recreational development and a pulp mill.

Detailed analyses were made of present energy consumption patterns at these various facilities and, in one case, the capital and operating costs for a geothermal installation were estimated. Because of high capital costs, the investigators tried to locate existing wells (previously drilled by oil and gas companies) that might be used for recovery of geothermal energy. However, they learned that it is common practice in the industry to plug non-productive wells with cement, thus rendering them useless for water extraction.

While the authors pointed out that more exhaustive analyses of costs and energy consumption patterns would be necessary before any recommendations could be made to proceed (or not proceed) with geothermal systems at any location, their approach is one that could be emulated by other investigators in any future consideration of geothermal applications.

A Simple Geothermal Installation



(Source: *A Preparatory Study for Application of Geothermal Energy in the Hinton/Edson Area of Alberta,* Jones F.W., M. Rahman, H.L. Lam and J.E. Sworder, October 31, 1983)

In general terms, it was learned from this study that recovery of geothermal energy is possible today and should be practical sometime in the future at several locations in Alberta. Also, it is not an exotic process that is in need of considerable research and development work; systems already exist to convert low-grade heat into electricity or use it directly to heat buildings as is done now in France, Hungary and the U.S.S.R.

While heating systems used in Canada today depend on heat sources other than geothermal, there is every reason to believe that new designs or designs borrowed from other countries would allow geothermal heat to be used in the future when conventional fuels become expensive or scarce.

Apartment buildings in Paris are heated by geothermal water. Well heads in the foreground are part of the water distribution system.

(Photo: Courtesy of Energy, Mines and Resources Canada)

Further Developments

Following this investigation, a feasibility study was undertaken by UMA Engineers Ltd, of Edmonton to determine the technical and economic viability of using geothermal energy to heat several large buildings in Edson. They concluded that capital and operating costs — in particular, the capital component associated with well drilling — made geothermal energy too expensive at this time when compared with heating by natural gas.

However, the study made it clear that a favorable position could result if the costs of well drilling could be avoided or substantially reduced. Perhaps one way to overcome this hurdle would be to convince oil and gas companies, when they are drilling wells near high gradient areas, to consider the possibility that some of their non-productive wells might be acceptable for the recovery of geothermal energy and, therefore, holes should be kept open until geothermal potential is properly evaluated.

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